User's Guide

Keysight W2635A and W2636A DDR3 BGA Probe Adapters for Oscilloscopes

KEYSIGHT TECHNOLOGIES

Notices

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CAUTION

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WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

W2635A and W2636A DDR3 BGA Probe Adapter Description

The W2635A and W2636A DDR3 BGA probe adapters provide signal access points to clock, strobe, data, address, and command signals from a DDR3 BGA package. These probe adapters let you make electrical and timing measurements with an Keysight Infiniium oscilloscope.

The W2635A and W2636A adapters are soldered in between the DRAM and PC board where the DRAM would normally be soldered. The adapters are designed with the PCB footprint on the bottom side and the DRAM footprint on the top side. The signals from the memory controller chip and DRAM are then passed to the top side of the BGA probe adapter where they can be accessed with oscilloscope probes.

The probe adapters are designed to work with Keysight InfiniiMax E2677A, N5381A, N5425A, and N5426A differential solder-in probes. The adapters have buried resistors (placed at the signals inside the BGA probe adapter) that connect the probed signals to the solder pads. These resistors isolate the DDR3 signal and the probe loading effect. This design minimizes capacitive loading of the probe heads and allows high-speed operation without impact on signal integrity.

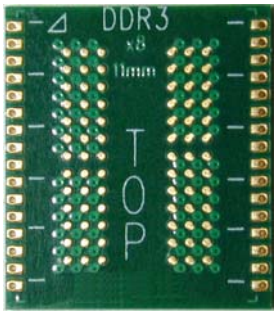
The W2635A x8 BGA probe adapter provides support for the x4 and x8 DRAM package footprints. The W2636A x16 BGA probe adapter provides support for the x16 DRAM package footprint. Each adapter comes in two different widths, 10 mm and 11 mm, to meet different spacing requirements between the DRAM placements on the PCB.

Technical Feature Summary

- Provides signal access points for DDR3 DRAM x4, x8 and x16 packages using JEDEC-standard common BGA footprints to the oscilloscope.
- Different BGA probe adapter widths, 10 mm and 11 mm, for different spacing requirements between the DRAM placements on the PCB.
- Buried resistors provide signal isolation and minimize capacitive loading.
- Probing with InfiniiMax probe heads, which includes the E2677A, N5381A, N5425A, and N5426A differential solder-in probe heads.
- Differential or single-ended probing of clock, strobe, data, address, and command signals.
- Tin plating of the DRAM footprint on the top side of the probe is compatible with leaded and no-lead DRAM balls.

The following pictures show the W2635A and W2636A BGA probe adapters.

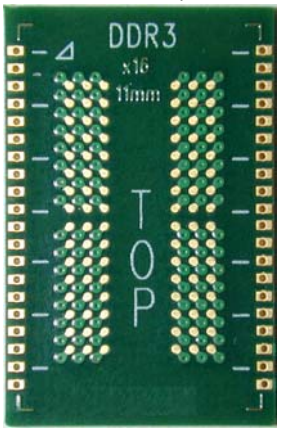
W2635A Top and Bottom View



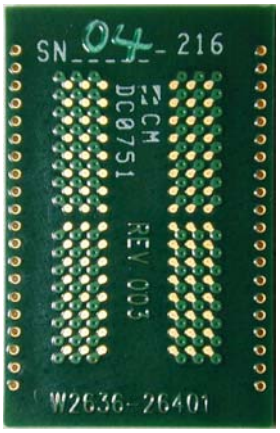
Top view (DRAM attach side)

Bottom view (PCB or DIMM attach side)

W2636A Top and Bottom View



Top view (DRAM attach side)



Bottom view (PCB or DIMM attach side)

Equipment Supplied

W2635A and W2636A

The following components have been shipped with your W2635A or W2636A BGA probe adapter:

- Each of the DDR3 BGA probe adapter models ships with 10 each of the probe adapters. Each model comes with either Option -010 or -011 for 10 mm or 11 mm widths.
- This *User's Guide*.

Configuration Guide

The following is a list of the InfiniiMax oscilloscope probe amplifiers and probe heads recommended for use with the DDR3 BGA probe adapters.

InfiniiMax probe amplifiers

Model number	Description
1169A	12-GHz differential and single-ended probe amplifier
1168A	10-GHz differential and single-ended probe amplifier
1134A	7-GHz differential and single-ended probe amplifier
1132A	5-GHz differential and single-ended probe amplifier

InfiniiMax probe heads

Model number	Description
N5381A	12-GHz solder-in differential probe head
N5382A	12-GHz differential browser probe head
E2677A	12-GHz solder-in differential probe head
N5425A	12-GHz ZIF probe head
N5426A	ZIF tips (10 each) used with the N5425A

N5381A

N5382A

E2677A

N5425A and N5426A

DDR3 BGA Probe Adapters Operation

Installing the DDR3 BGA Probe Adapter

The W2635A or W2636A BGA probe adapter is installed by soldering it to the BGA footprint on a PC board where the DRAM would normally be soldered. The DDR3 DRAM may then be soldered to the top side of the BGA probe adapter. This attachment may occur in any order. (The BGA probe adapter can be soldered first to the PCB, then the DDR3 DRAM can be soldered to the BGA probe adapter, or the DDR3 DRAM can be soldered first to the BGA probe adapter, then the BGA probe adapter assembly can be soldered to the PCB.)

The probe is designed to tolerate lead-free soldering temperature profiles. However, it is always recommended that the minimum temperature required for soldering be applied and that the minimum number of heating and cooling cycles be applied to reduce risk of any damage to the probe.

The BGA probe adapter is supplied without solder balls attached. Depending on the exact attachment order, either leaded or lead-free solder may be preferred to attach the BGA probe adapter to the PCB or DRAM. The design of the probe supports either method.

Some general guidelines are:

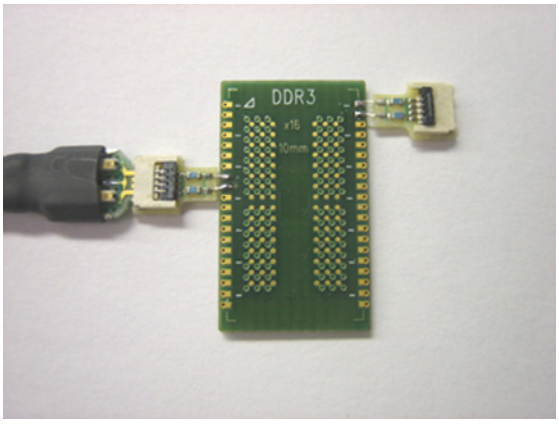
- When soldering the DRAM onto the probe, the temperature may need to rise to the point where the solder balls under the probe soften. Some method of holding the probe in place when soldering the DRAM may be necessary.
- Normal surface cleaning and preparation procedures for BGA soldering are recommended.

If you do not have the in-house expertise to attach the BGA probe adapter and DRAM, contract manufacturers with this expertise may be willing to perform the attachment for a fee. More information on BGA soldering and rework techniques that may be useful in attaching the probe can be found at:

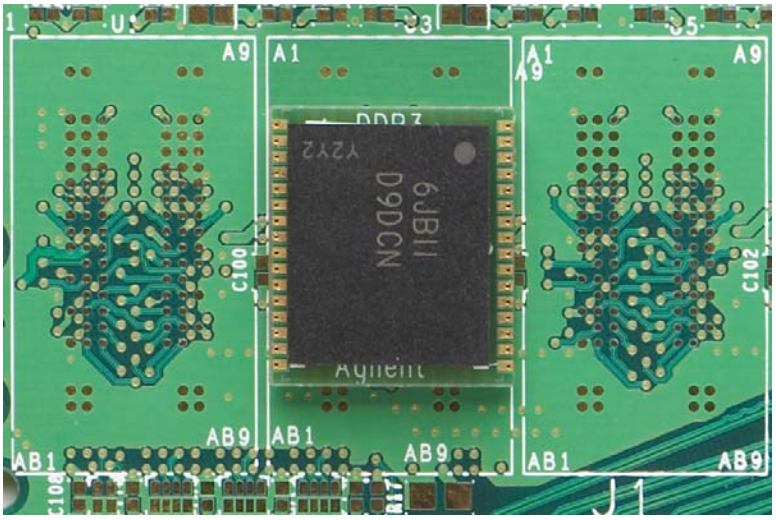
- http://www.circuitrework.com/guides/9-1-1.shtml
- http://www.keysight.com/find/ddr3bga-scope

Installing the InfiniiMax Probe

Instructions that come with the InfiniiMax probe provide details on the proper soldering procedures for the InfiniiMax probe heads. The picture below shows an InfiniiMax N5425A and N5426A ZIF probe head connected to the W2636A DDR3 BGA probe adapter.



The picture below shows the W2635A BGA probe adapter after being soldered onto a printed-circuit board.



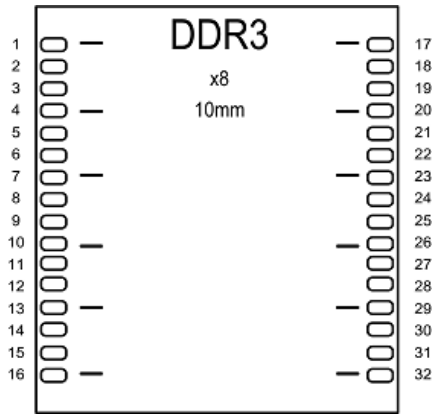
DDR3 BGA Probe Adapters Dimensions, Pad Numbering and Location

W2635-010 Dimensions, Pad Numbering and Location

Size:

- Height = 13.97 mm (0.550 in)
- Width = 11.176 mm (0.440 in)
- Thickness = 1.575 mm (0.062 in)

Bringing 20x signals to SMT pads for probing
Providing 12x GND pads (6x on either side of DDR3 BGA probe adapter)
75-ohm buried tip resistor



Pin #	Signal	Signal	Pin #
1	GND	GND	17
2	LDQS	DQ1	18
3	LDQS#	DQ3	19
4	GND	GND	20
5	RAS	DQ7	21
6	CAS	DQ5	22
7	GND	GND	23
8	ODT	CK	24
9	CS0	CK#	25
10	GND	GND	26
11	CS1	CKE	27
12	WE	A10	28
13	GND	GND	29
14	BA0	BA1	30
15	BA2	A12	31
16	GND	GND	32

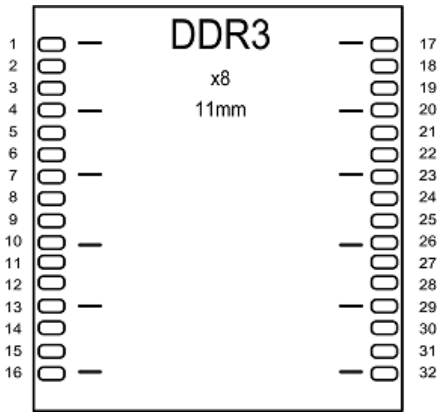
Table 1. W2635-010 pad numbering

W2635-011 Dimensions, Pad Numbering and Location

Size:

- Height = 13.97 mm (0.550 in)
- Width = 12.192 mm (0.480 in)
- Thickness = 1.575 mm (0.062 in)

Bringing 20x signals to SMT pads for probing
Providing 12x GND pads (6x on either side of DDR3 BGA probe adapter)
75-ohm buried tip resistor



Pin #	Signal	Signal	Pin #
1	GND	GND	17
2	LDQS	DQ1	18
3	LDQS#	DQ3	19
4	GND	GND	20
5	RAS	DQ7	21
6	CAS	DQ5	22
7	GND	GND	23
8	ODT	CK	24
9	CS0	CK#	25
10	GND	GND	26
11	CS1	CKE	27
12	WE	A10	28
13	GND	GND	29
14	BA0	BA1	30
15	BA2	A12	31
16	GND	GND	32

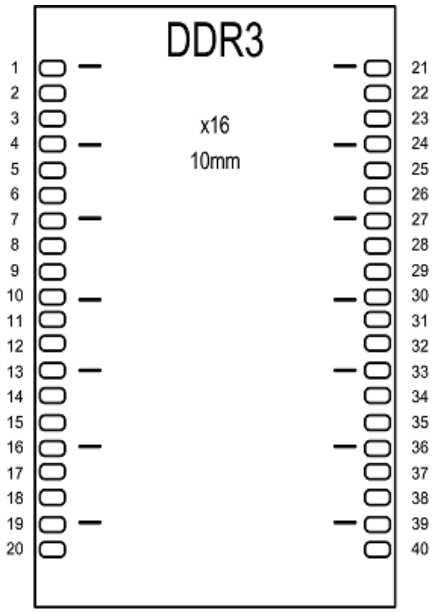
Table 2. W2635-011 pad numbering

W2636-010 Dimensions, Pad Numbering and Location

Size:

- Height = 19.05 mm (0.750 in)
- Width = 11.176 mm (0.440 in)
- Thickness = 1.575 mm (0.062 in)

Bringing 26 signals to SMT pads for probing
Providing 14 GND pads (7 on either side of DDR3 BGA probe adapter)
75-ohm buried tip resistor



Pin #	Signal	Signal	Pin #
1	GND	GND	21
2	DQ13	DQ12	22
3	DQ19	DQ14	23
4	GND	GND	24
5	DQ0	UDQS#	25
6	LDQS	UDQS	26
7	GND	GND	27
8	LDQS#	DQ3	28
9	RAS	DQ5	29
10	GND	GND	30
11	CAS	CK	31
12	ODT	CK#	32
13	GND	GND	33
14	CS0	CKE	34
15	CS1	A10	35
16	GND	GND	36
17	WE	BA1	37
18	BA0	A12	38
19	GND	GND	39
20	BA2	A11	40

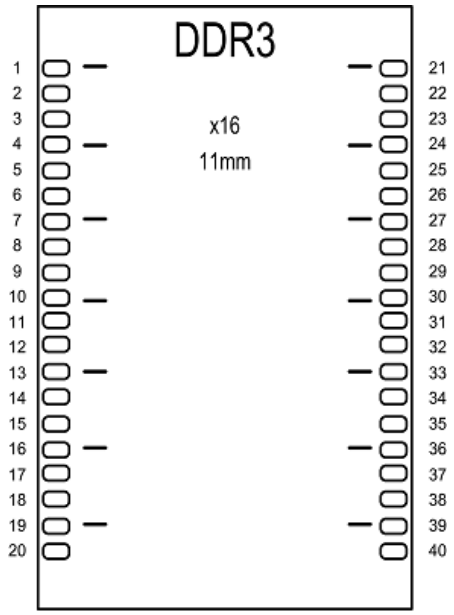
Table 3. W2636-010 pad numbering

W2636-011 Dimensions, Pad Numbering and Location

Size:

- Height = 19.05 mm (0.750 in)
- Width = 12.192 mm (0.440 in)
- Thickness = 1.575 mm (0.062 in)

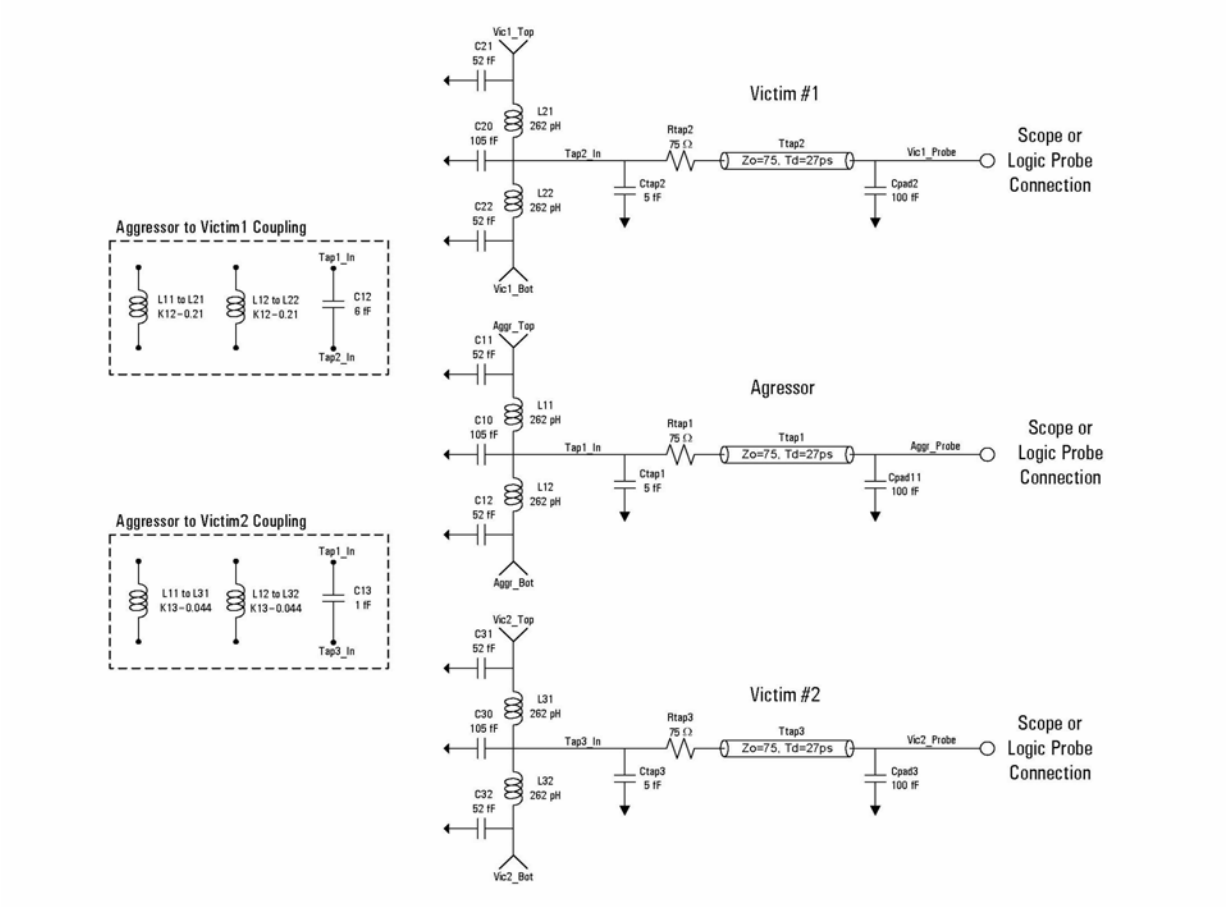
Bringing 26 signals to SMT pads for probing
Providing 14 GND pads (7 on either side of DDR3 BGA probe adapter)
75-ohm buried tip resistor



Pin #	Signal	Signal	Pin #
1	GND	GND	21
2	DQ13	DQ12	22
3	DQ9	DQ14	23
4	GND	GND	24
5	DQ0	UDQS#	25
6	LDQS	UDQS	26
7	GND	GND	27
8	LDQS#	DQ3	28
9	RAS	DQ5	29
10	GND	GND	30
11	CAS	CK	31
12	ODT	CK#	32
13	GND	GND	33
14	CS0	CKE	34
15	CS1	A10	35
16	GND	GND	36
17	WE	BA1	37
18	BA0	A12	38
19	GND	GND	39
20	BA2	A11	40

Table 4. W2636-011 pad numbering

DDR3 BGA Probe Adapter Load Model



Spice Decks for W2635A and W2636A Probes

SPICE Deck of Load Model without Oscilloscope Probe

```
*********************************************************************************
*** Equivalent Load Model: W2635A and W2636A DDR3 Probes with no probes attached
*** June 2007
*** Rev001
***
***    This SPICE subcircuit models the input impedance of the W2635A and W2636A DDR3
***    probes.  This models the effect of the probe loading on the system.
***    This is a 3-line model which includes mutual inductive and capacitive coupling
***    from one aggressing line to two adjacent victim pins (K12 & K13).
***    This model is accurate up to 6 GHz for input impedance simulations.
***
***     Port Description:
***
***       Aggr_Top    = Top pad of the probe for the aggressor line
***       Aggr_Bot    = Bottom pad of the probe for the aggressor line
***       Aggr_Probe = Probe pad along perimeter of the probe for the
***          aggressor line
***       Vic1_Top    = Top pad of the probe for the Victim #1 line (K12, C12)
***       Vic1_Bot    = Bottom pad of the probe for the Victim #1 line (K12, C12)
***       Vic1_Probe = Probe pad along perimeter of the probe for the Victim #1
***          line (K13, C13)
***       Vic2_Top    = Top pad of the probe for the Victim #2 line (K12, C12)
***       Vic2_Bot    = Bottom pad of the probe for the Victim #2 line (K12, C12)
***       Vic2_Probe = Probe pad along perimeter of the probe for the Victim #2
***          line (K13, C13)
***
***         NOTE:  The probe ground is assumed to be ideal and is labeled node 0
***         NOTE:  K23, C23 is negligible
***
***    This model is used to simulate the load of the probe with no oscilloscope
***    attached.
***
***
*********************************************************************************

.subckt W2635_36_RevA1_Model_NoProbe_SUBCKT
+ Aggr_Top Aggr_Bot Aggr_Probe
+ Vic1_Top Vic1_Bot Vic1_Probe
+ Vic2_Top Vic2_Bot Vic2_Probe

.param Zint=50
.param Tint='(169p)*0.062'
.param Lint='Zint*Tint'
.param Cint='Tint/Zint'
```

```
.param K12=0.21
.param K13=0.044
.param C12=6f
.param C13=1f

.param Rtap=75
.param Ctap=5f
.param Ztap=75
.param Ttap='(169p)*0.157'
.param Cpad1=100f

CC10 0 Tap1_In C='Cint/2'
CC11 0 Aggr_Top C='Cint/4'
CC12 0 Aggr_Bot C='Cint/4'
CC20 0 Tap2_In C='Cint/2'
CC21 0 Vic1_Top C='Cint/4'
CC22 0 Vic1_Bot C='Cint/4'
CC30 0 Tap3_In C='Cint/2'
CC31 0 Vic2_Top C='Cint/4'
CC32 0 Vic2_Bot C='Cint/4'
CCcouple12 Tap2_In Tap1_In C=C12
CCcouple13 Tap3_In Tap1_In C=C13
CCpad1 0 Aggr_Probe C=Cpad1
CCpad2 0 Vic1_Probe C=Cpad1
CCpad3 0 Vic2_Probe C=Cpad1
CCtap1 0 Tap1_In C=Ctap
CCtap2 0 Tap2_In C=Ctap
CCtap3 0 Tap3_In C=Ctap
LL11 Aggr_Top Tap1_In 'Lint/2'
LL12 Tap1_In Aggr_Bot 'Lint/2'
LL21 Vic1_Top Tap2_In 'Lint/2'
LL22 Tap2_In Vic1_Bot 'Lint/2'
LL31 Vic2_Top Tap3_In 'Lint/2'
LL32 Tap3_In Vic2_Bot 'Lint/2'
RRtap1 Tap1_In _net4577 Rtap
RRtap2 Tap2_In _net4578 Rtap
RRtap3 Tap3_In _net4540 Rtap
TTtap1 _net4577 Aggr_Probe 0 0 Z=Ztap E=360 F='1/(Ttap)'
TTtap2 _net4578 Vic1_Probe 0 0 Z=Ztap E=360 F='1/(Ttap)'
TTtap3 _net4540 Vic2_Probe 0 0 Z=Ztap E=360 F='1/(Ttap)'

.ends W2635_36_RevA1_Model_NoProbe_SUBCKT
```

SPICE Deck of Load Model with Oscilloscope Probe

```
********************************************************************************
*** Equivalent Load Model : W2635A and W2636A DDR3 Probes with Oscilloscope
*** Probe Attached
*** June 2007
*** Rev002
***
***    This SPICE subcircuit models the input impedance of the W2635A and W2636A DDR3
***    probes.  This models the effect of the probe loading on the system.
***    This is a 3-line model which includes mutual inductive and capacitive coupling
***    from one aggressing line to two adjacent victim pins (K12 & K13).
***    This model is accurate up to 6 GHz for input impedance simulations.
***
***     Port dDescription:
***
***          Aggr_Top = Top pad of the probe for the aggressor line
***          Aggr_Bot = Bottom pad of the probe for the aggressor line
***          Aggr_Probe = Probe pad along perimeter of the probe for the aggressor
***             line
***          Vic1_Top = Top pad of the probe for the Victim #1 line (K12, C12)
***          Vic1_Bot = Bottom pad of the probe for the Victim #1 line (K12, C12)
***          Vic1_Probe = Probe pad along perimeter of the probe for the Victim #1
***             line (K13, C13)
***          Vic2_Top = Top pad of the probe for the Victim #2 line (K12, C12)
***          Vic2_Bot = Bottom pad of the probe for the Victim #2 line (K12, C12)
***          Vic2_Probe = Probe pad along perimeter of the probe for the Victim #2
***             line (K13, C13)
***
***         NOTE:  The probe ground is assumed to be ideal and is labeled node 0
***         NOTE:  K23, C23 is negligible
***
***    This model is used to simulate the load of the probe with the Keysight N5425A ZIF
***    pProbe head with the N5426A ZIF tTip attached and soldered to the observation
***    pads on the probe.
***
***
********************************************************************************

.subckt W2635_36_RevA1_Model_ScopeProbe_SUBCKT
+ Aggr_Top Aggr_Bot Aggr_Probe
+ Vic1_Top Vic1_Bot Vic1_Probe
+ Vic2_Top Vic2_Bot Vic2_Probe

.param Zint=50
.param Tint='(169p)*0.062'
.param Lint='Zint*Tint'
.param Cint='Tint/Zint'
.param K12=0.21
```

```
.param K13=0.044
.param C12=6f
.param C13=1f

.param Rtap=75
.param Ctap=5f
.param Ztap=75
.param Ttap='(169p)*0.157'
.param Cpad1=100f

CC1 _net4933 _net4991 C=14.75fF
CC10 0 Tap1_In C='Cint/2'
CC11 0 Aggr_Top C='Cint/4'
CC12 0 Aggr_Bot C='Cint/4'
CC2 _net4941 _net4991 C=6.3fF
CC20 0 Tap2_In C='Cint/2'
CC21 0 Vic1_Top C='Cint/4'
CC22 0 Vic1_Bot C='Cint/4'
CC30 0 Tap3_In C='Cint/2'
CC31 0 Vic2_Top C='Cint/4'
CC32 0 Vic2_Bot C='Cint/4'
CC33 _net5160 _net5186 C=6.3fF
CC34 _net5152 _net5186 C=14.75fF
CC35 _net5309 _net5335 C=6.3fF
CC36 _net5301 _net5335 C=14.75fF
CCcouple12 Tap2_In Tap1_In C=C12
CCcouple13 Tap3_In Tap1_In C=C13
CCn1 _net4948 _net5008 C=556.5fF
CCn2 _net4963 _net5008 C=40.93fF
CCn3 _net5182 _net5190 C=40.93fF
CCn4 _net5167 _net5190 C=556.5fF
CCn5 _net5331 _net5339 C=40.93fF
CCn6 _net5316 _net5339 C=556.5fF
CCp1 _net4951 _net5031 C=556.5fF
CCp2 _net4960 _net5031 C=40.93fF
CCp3 _net5179 _net5191 C=40.93fF
CCp4 _net5170 _net5191 C=556.5fF
CCp5 _net5328 _net5340 C=40.93fF
CCp6 _net5319 _net5340 C=556.5fF
CCpad1 0 Aggr_Probe C=Cpad1
CCpad2 0 Vic1_Probe C=Cpad1
CCpad3 0 Vic2_Probe C=Cpad1
CCtap1 0 Tap1_In C=Ctap
CCtap2 0 Tap2_In C=Ctap
CCtap3 0 Tap3_In C=Ctap
LL1 _net4933 _net4936 1.356nH
LL11 Aggr_Top Tap1_In 'Lint/2'
```

```
LL12 Tap1_In Aggr_Bot 'Lint/2'
LL2 _net4941 _net4942 345.2pH
LL21 Vic1_Top Tap2_In 'Lint/2'
LL22 Tap2_In Vic1_Bot 'Lint/2'
LL31 Vic2_Top Tap3_In 'Lint/2'
LL32 Tap3_In Vic2_Bot 'Lint/2'
LL33 _net5160 _net5161 345.2pH
LL34 _net5152 _net5155 1.356nH
LL35 _net5309 _net5310 345.2pH
LL36 _net5301 _net5304 1.356nH
LLn1 _net4948 _net4946 3.815nH
LLn2 _net4963 _net4966 5.731nH
LLn3 _net5182 _net5185 5.731nH
LLn4 _net5167 _net5165 3.815nH
LLn5 _net5331 _net5334 5.731nH
LLn6 _net5316 _net5314 3.815nH
LLom _net5031 0 1uH
LLom2 _net5038 0 2nH
LLom3 _net5193 0 2nH
LLom4 _net5191 0 1uH
LLom5 _net5342 0 2nH
LLom6 _net5340 0 1uH
LLp1 _net4951 _net4954 3.815nH
LLp2 _net4960 _net4958 5.731nH
LLp3 _net5179 _net5177 5.731nH
LLp4 _net5170 _net5173 3.815nH
LLp5 _net5328 _net5326 5.731nH
LLp6 _net5319 _net5322 3.815nH
RR1 _net4936 _net5008 948.2
RR2 _net4942 _net5008 36.88
RR3 _net5161 _net5190 36.88
RR4 _net5155 _net5190 948.2
RR5 _net5310 _net5339 36.88
RR6 _net5304 _net5339 948.2
RRn1 _net4946 _net5031 38.32
RRn2 _net4966 _net5031 30.4
RRn3 _net5008 _net5031 25kOhm
RRn4 _net5190 _net5191 25kOhm
RRn5 _net5185 _net5191 30.4
RRn6 _net5165 _net5191 38.32
RRn7 _net5339 _net5340 25kOhm
RRn8 _net5334 _net5340 30.4
RRn9 _net5314 _net5340 38.32
RRom _net5038 _net5031 250
RRom1 _net5193 _net5191 250
RRom2 _net5342 _net5340 250
RRp1 _net4954 _net4991 38.32
```

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RRp2 _net4958 _net4991 30.4
RRp3 _net5031 _net4991 25kOhm
RRp4 _net5191 _net5186 25kOhm
RRp5 _net5177 _net5186 30.4
RRp6 _net5173 _net5186 38.32
RRp7 _net5340 _net5335 25kOhm
RRp8 _net5326 _net5335 30.4
RRp9 _net5322 _net5335 38.32
RRtap1 Tap1_In _net4577 Rtap
RRtap2 Tap2_In _net5076 Rtap
RRtap3 Tap3_In _net5224 Rtap
RRtipn 0 _net5008 64.35
RRtipn1 0 _net5190 64.35
RRtipn2 0 _net5339 64.35
RRtipp Aggr_Probe _net4991 64.35
RRtipp1 Vic1_Probe _net5186 64.35
RRtipp2 Vic2_Probe _net5335 64.35
TTtap1 _net4577 Aggr_Probe 0 0 Z=Ztap E=360 F='1/(Ttap)'
TTtap2 _net5076 Vic1_Probe 0 0 Z=Ztap E=360 F='1/(Ttap)'
TTtap3 _net5224 Vic2_Probe 0 0 Z=Ztap E=360 F='1/(Ttap)'

.ends W2635_36_RevA1_Model_ScopeProbe_SUBCKT
```

Characteristics, Regulatory, and Safety Information

Electrical Characteristics

The following electrical characteristics are not specifications, but are typical electrical characteristics for the analysis of the W2635A and W2636A probes with the InfiniiMax oscilloscope probe.

Table 1 Electrical characteristics

Operating Transfer Rate	1600 Mb/s
Bandwidth (3 dB)	4 GHz
Rise time	88 ps
Input Impedance	25 kΩ

Operating Characteristics

The following operating characteristics are not specifications, but are typical operating characteristics for the analysis of the W2635A and W2636A probes with the oscilloscope probe.

Table 2 Environmental characteristics (Operating)

Temperature	20° to + 30° C (+68° to +86° F)
Altitude	4,600 m (15,000 ft)
Humidity	Up to 50% noncondensing. Avoid sudden, extreme temperature changes which could cause condensation on the circuit board. For indoor use only.

Safety Notices

This apparatus has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under "Safety Symbols."

Warnings

Use only the recommended power supply.

If you energize this instrument by an auto transformer (for voltage reduction or mains isolation), the common terminal must be connected to the earth terminal of the power source.

If it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.

Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

Do not install substitute parts or perform any unauthorized modification to the instrument.

Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.

Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Do not use the instrument in a manner not specified by the manufacturer.

Safety Symbols

Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product.

Hazardous voltage symbol

Earth terminal symbol: Used to indicate a circuit common connected to grounded chassis

Regulatory Information

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